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Award Number: DAMD17-01-1-0563

TITLE: Role of the APAf-1Caspase-9 Pathway in Breast Tumor Development

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REPORT DATE: September 2003

TYPE OF REPORT: Final

PREPARED FOR: U.S. Army Medical Research and Materiel Command
Fort Detrick, Maryland 21702-5012

DISTRIBUTION STATEMENT: Approved for Public Release;
Distribution Unlimited

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REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 074-0188

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	September 2003	Final (15 Aug 2001 - 14 Aug 2003)

4. TITLE AND SUBTITLE
Role of the APAf-1Caspase-9 Pathway in Breast Tumor Development

5. FUNDING NUMBERS
DAMD17-01-1-0563

6. AUTHOR(S)

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8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)
U.S. Army Medical Research and Materiel Command
Fort Detrick, Maryland 21702-5012

10. SPONSORING / MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION / AVAILABILITY STATEMENT
Approved for Public Release; Distribution Unlimited

12b. DISTRIBUTION CODE

13. ABSTRACT (Maximum 200 Words)

The Aim of this concept award project was to assess the function of Apaf-1/Caspase-9 in tumorigenesis in the mouse. We planned to use mutant mice (FOG mice) expressing a hypomorphic allele of Apaf-1 gene in the breast as the Apaf-1 KO mutation is embryonic lethal. Crosses of heterozygous FOG+/- mice yielded mostly FOG-/- mice that exhibited major cranial defects and died shortly after birth. Thus, FOG mutant could be not be used to assess the role of Apaf-1 in tumor development in vivo. In parallel studies, we have developed a system to express stably small (21-29 bp) interfering RNAs (siRNAs) targeted against Apaf-1 transcripts. Eight hairpin oligonucleotides were designed to target four different regions of the Apaf-1 transcript. We constructed and tested multiples constructs and identified a RNAi construct that effectively inhibit the expression of Apaf-1 protein in breast cancer cells.

14. SUBJECT TERMS
Breast, Research

15. NUMBER OF PAGES
8

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	Unlimited

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INTRODUCTION

Recent evidence indicates that alterations of the cell death pathway contribute to the pathogenesis of many diseases including cancer and may play a role in resistance to therapy (1). However, the contribution of specific pathways of apoptosis to cancer development is poorly understood and the role that apoptosis plays in the resistance of tumors to therapy is highly controversial. A major pathway of apoptosis links intracellular death stimuli to the activation of caspase-9 through Apaf-1 (2). It has been shown that transformed mouse fibroblasts deficient in Apaf-1 exhibit increased tumorigenicity and are less susceptible to several apoptotic stimuli (3). Furthermore, There is evidence that Apaf-1 expression is important for melanoma development (4) and low level Apaf-1 activity has been found in ovarian cancer (5-6). However, direct evidence that the Apaf-1/caspase-9 pathway is important for tumor developent is lacking. Mice deficient in Apaf-1 die during development or shortly after birth (7), precluding their use in models of cancer development. Our hypothesis is that the endogenous Apaf-1/caspase-9 pathway suppresses tumor development through the activation of apoptosis in cancer-prone epithelial cells in the breast. To test this hypothesis, we propose to study mutant mice expressing a hypomorphic allele of Apaf-1.

BODY

This is the final report for a project funded for 1 year entitled "Role of Apaf-1/Caspase-9 pathway in Breast Tumor Development. The Aim of the project was to assess the function of Apaf-1/Caspase-9 in tumorigenesis in the mouse. Initially we proposed to generate transgenic mice in which dominant negative forms of Apaf-1 or Caspase-9 are expressed in the breast. A potential problem with this approach is that dominant negative forms need to be expressed at high levels relative to those of the endogenous proteins for inhibitory activity. To avoid this problem, we decided to use FOG mutant mice from Jackson laboratory which exhibit a hypomorphic Apaf-1 allele. These mutant mice lack detectable expression of Apaf-1 protein and the Apaf-1 transcripts are 10-20 fold less abundant than those in wild-type mice (8). Most FOG mutant mice were reported to be viable (8) and therefore we proposed to use these mice to assess the role of Apaf-1 in tumor development in vivo. To determine the feasibility of using FOG mutant mice to assess the role of Apaf-1 in tumor development, we crossed heterozygous FOG+/- mice and determined the genotype/phenotype of born mice. We found that of 19 born mice, 5 were FOG+/+, 10 FOG+/- and 4 were FOG-/- which is consistent with the expected pattern of mendelian inheritance. Of the four born FOG-/- mice, 3 had major cranial defects and died shortly after birth. The remaining FOG-/- mouse was runted and died 12 weeks after birth. Based on these pilot studies, we concluded that FOG mice cannot be used to study the contribution of Apaf-1 in breast cancer development in vivo.

We have developed a system to express stably small (21-29 bp) interfering RNAs (siRNAs) targeted against Apaf-1 transcripts. RNA interference (RNAi) is the process of sequence-specific gene silencing in animal and plants initiated by double-stranded RNA that results in the enzymatic degradation of complementary RNA (9-11). Eight hairpin oligonucleotides were designed to target four different regions of the Apaf-1 transcript. The sequence of the sense (s) and antisense (as) oligonucleotides are shown below. The ability of the optimal candidates were tested by transient co-transfection of the retroviral plasmid and a construct expressing Apaf-1.

1. Apaf-1 RNAi 1s 5' CTA GAC CGT CGA CGG ACA TCA AGA CCT ACT TCG GTA GGA TGT CTT GAT GTC CTT TTT CTA GAG CTC AAC 3'

2. Apaf-1 RNAi 1as 5' GTT GAG CTC TAG AAA AAG GAC ATC AAG ACA TCC TAC CGA AGT AGG ATG TCT TGA TGT CCG TCG ACG GTC TAG 3'

3. Apaf-1 RNAi 2s 5' GTA GAC CGT CGA CCC TAC GTA TCA TTC TAC AAT TCG TTG TAG AAT GAT ACG TAG GTT TTT CTA GAG CTC AAC 3'

4. Apaf-1- RNAi 2as 5' GTT GAG CTC TAG AAA AAC CTA CGT ATC ATT CTA CAA CGA ATT GTA GAA TGA TAC GTA GGG TCG ACG GTC TAG 3'

5. Apaf-1 RNAi 3s 5' CTA GAC CGT CGA CGG TCA CCA TAC ATG GAA TGT TCG CAT TCC ATG TAT GGT GAC CTT TTT CTA GAG CTC AAC 3'

6. Apaf-1 RNAi3as 5' GTT GAG CTC TAG AAA AAG GTC ACC ATA CAT GGA ATG CGA ACA TTC CAT GTA TGG TGA CCG TCG ACG GTC TAG 3'

7. Apaf-1 s(H1) 5' GAT CCC CGG ACA TCA AGA CAT CCT ACT TCA AGA GAG TAG GAT GTC TTG ATG TCC TTT TTG G AAA 3'

8. Apaf-1as(H1) 5' AGC TTT TCC AAA AAG GAC ATC AAG ACA TCC TAC TCT CTT GAA GTA GGA TGT CTT GAT GTC CGG G 3'

The sense and antisense oligonucleotides for each region were incubated annealing buffer (10nM TRIS-HCl pH 7.5, 100mM NaCl, 1mM EDTA pH 8.0), digested with SalI and XbaI, and ligated into three different expression plasmids. These included pAV U6+27 (a gift of Dr. Engelke, the University of Michigan), pMND-Banshee (a gift of John Rossi, University of California, City of Hope and pSUPER (9-11). These plasmids use different promoters and regulatory sequences and we wished to compare their abilities to inhibit Apaf-1 expression. We transfected these expression and control plasmids into human embryonic HEK293T cells, A2780 and MCF-7 cancer cells. Immunoblotting analysis with anti-Apaf-1 antibody revealed that the plasmid expressing RNAi oligonucleotides # 7 and # 8 was particularly effective in inhibiting Apaf-1 protein in HEK293T cells as determined in transient assays (Fig. 1). We also transfected the same construct into A2780 and MCF7 cells and selected cell clones. Immunoblotting analysis revealed several cell clones which were deficient in Apaf-1 when compared to parental cells (Fig. 2). We plan to use this construct to study the role of Apaf-1 in the regulation of cancer cell growth and response to chemotherapeutic drugs.

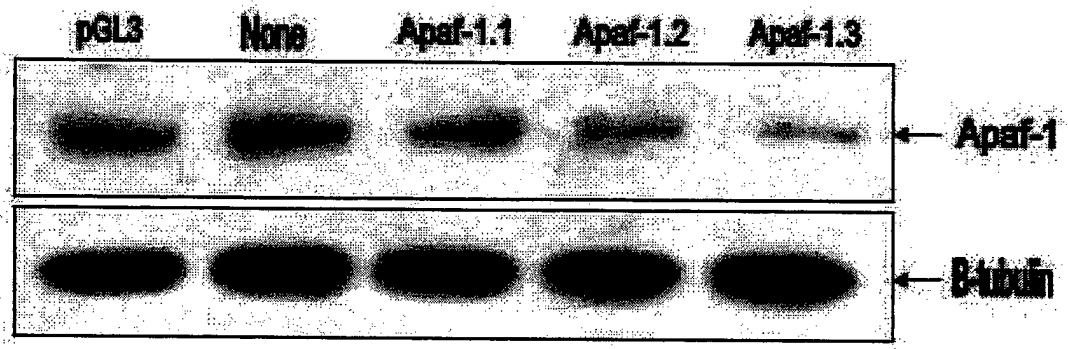

FIGURE 1. Inhibition of Apaf-1 protein expression by RNAi constructs. HEK293T cells were transiently transfected with control plasmid (pGL2), no plasmid (None) or three plasmids expressing hairpin RNAi oligonucleotides Apaf-1.1-3. 48 hrs after transfection, cellular extracts were immunoblotted with monoclonal anti-Apaf-1 antibody. Loading control is shown below.

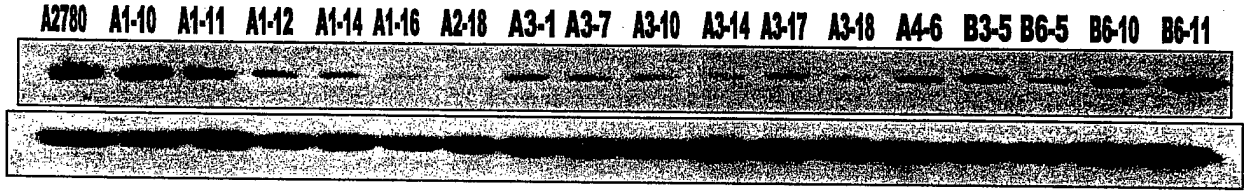

FIGURE 2. Inhibition of Apaf-1 protein expression by RNAi construct Apaf-1.3. A2780 cells were transfected with plasmid expressing hairpin RNAi oligonucleotide Apaf-1.3. Cell clones were isolated and cellular extracts from individual clones were immunoblotted with monoclonal anti-Apaf-1 antibody. Several clones are deficient in Apaf-1 including A1-16 and A2-18. Immunoblotting with anti-β-tubulin (loading control is shown in lower panel).

KEY RESEARCH ACCOMPLISMENTS:

- Development of a RNAi construct to inhibit expression of Apaf-1

REPORTABLE OUTCOMES:

RNAi oligonucleotide sequences capable of inhibiting Apaf-1 expression

CONCLUSIONS:

FOG mutant mice expressing hypomorphic allele of Apaf-1 could not be used to study the role of Apaf-1 in tumor development in vivo due to short survival of mutant mice. We have developed a system to express stably small (21-29 bp) interfering RNAs (siRNAs) targeted against Apaf-1 transcripts. Eight hairpin oligonucleotides were designed to target four different regions of the Apaf-1 transcript. We have identified a construct that effectively inhibit the expression of Apaf-1 in breast cancer cells.

PERSONNEL RECEIVING PAY FROM RESEARCH EFFORTS:

Nesrin Ozoren, Ph. D.

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